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**Fractal behavior in
dielectric spectroscopy.**
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ABOUT THE COVER

These computer-generated images result from an application of fractal geometry, a mathematical treatment of real shapes that does not depend on approximation by the triangles, circles, and squares of conventional geometry. Fractal geometry includes the notion of self-similarity—the tendency of natural forces to repeat themselves.

This concept is used by researchers in many fields. An article about one of them begins on page 72. It concerns dielectric spectroscopy and the development and degradation of colloidal structures.

The cover photo, supplied by IBM's Research Div. (© 1984), was made by H.O. Peitgen and R. Richter of Univ. of Bremen.

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TRENDSURVEY

Use of analytical instruments and equipment, 1986

Changes in demographics cloud the results of our annual survey of the present and planned use of 33 types of instruments, but average plans to acquire decrease only slightly.

AT FIRST GLANCE, the results of our latest annual Trends survey are troublesome. Average present use of analytical instruments and equipment drops to 30.7% from 1985's 31.3%. Average plans to acquire fall to 4.67% from last year's 5.13%. That is almost a 2% drop in present use and almost a 9% drop in plans to acquire.

But that is on the basis of the raw data, and overlooks a significant change in the demographics of the respondents, particularly in the disciplines represented.

Engineering climbs almost 24% to 25.6% of the total sample, while those in life science or medicine jump almost 7% to 20.9% of the total. At the same time, those in physical science drop some 13% to 20.9% of the total, and respondents giving no answer to the discipline question climb more than 50% to 4.1% of the total sample.

Some idea of the importance of this is revealed by an examination of the data that are tabulated with this article. The highest present use is recorded for only three categories of instruments and equipment by the engineering discipline: electron microscopes, strip-chart recorders, and x-y plotting recorders. For plans to acquire, the engineering discipline keeps top honors only for the two recorder categories.

Life science or medicine shows highest present use for only 10 categories, which drops to 8 categories for plans to acquire: centrifuges, thin-layer chromatographs, electrophoresis apparatus, pH meters, specific ion electrodes, fluorescence spectrophotometers, UV/vis spectrophotometers, and automatic titrators.

Conversely, physical science—whose representation fell—has the highest percentages for 20 categories in present use and 23 categories in plans to acquire.

With these data in mind, one is not surprised to find that normalizing the results on the basis of changes in disciplines, employers, and job functions leads to a different picture. After normalizing so that 1986 data are comparable to 1985's, average present use this year is 31.4%, essentially the same as last year's 31.3%. Normalizing also raises this year's average plans to acquire to 4.78%, only 0.35% below the average for last year, or less than a 7% drop.

Other ways to look at the data include examining the number of categories that show increases or decreases, examining the magnitude of those changes, and examining the ranking or order of the various categories of instruments and equipment.

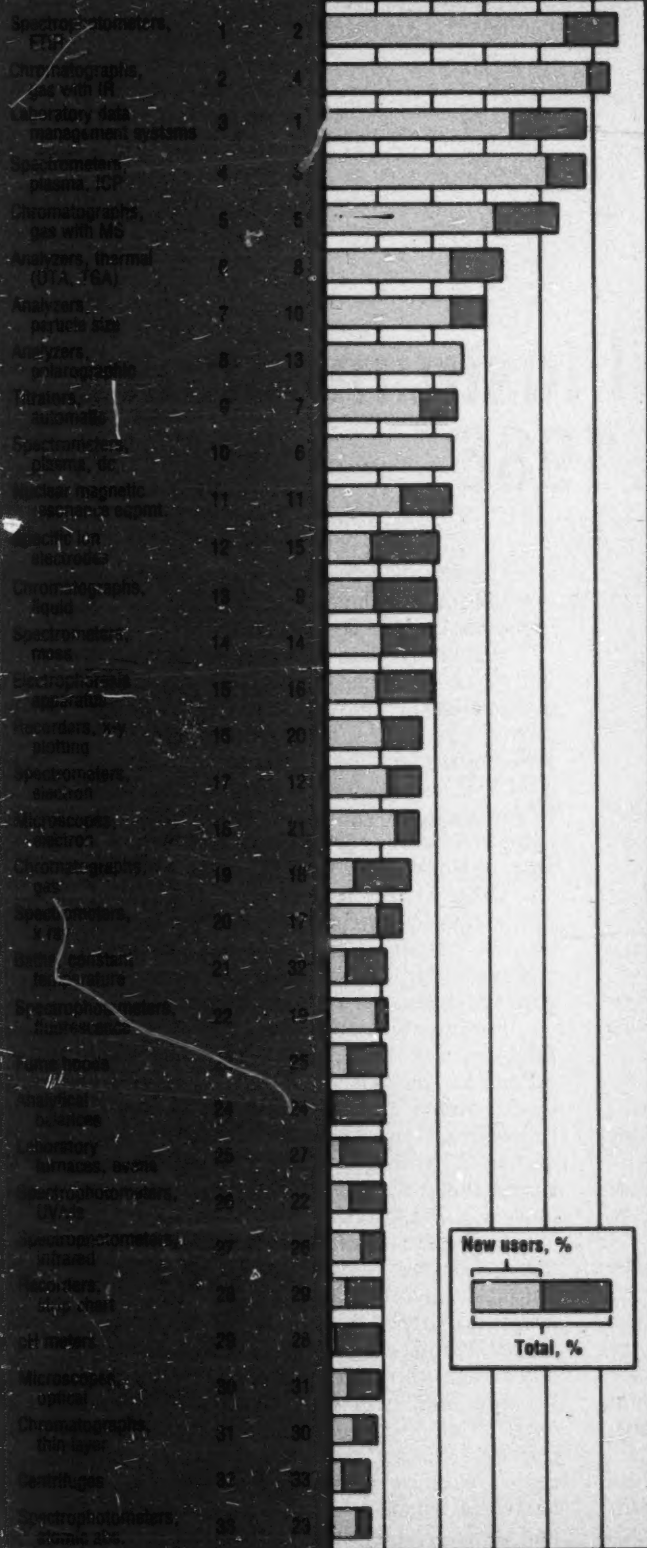
For present use, 14 categories show increases, 1 is the same, and 18 show losses from last year. The largest gainers are laboratory data management systems, up 3.0 points from 30.1% to 33.1%, and laboratory furnaces and ovens and electrophoresis apparatus, each up 2.7 points. Losers are topped by infrared spectrophotometers, down 5.3 points; analytical balances down 4.5; and gas chromatographs, down 3.8.

In plans to acquire, 10 categories are up and 23 are down. Constant-temperature baths gained 1.3 points, thermal analyzers 1.2, and x-y plotting recorders 0.9. Losers are topped by liquid chromatographs, down 2.9 points; laboratory data management systems, down 2.4; and gas chromatographs, down 2.0 points.

Rankings by present use are shown in the first bar chart for all 33 categories and "other" on a total sample basis. On that same basis, rankings for plans to acquire are led by laboratory data management systems, analytical balances, fume hoods, laboratory furnaces and ovens, and liquid chromatographs. Last year, liquid chromatographs occupied third place, fume hoods fourth, and gas chromatographs fifth, while furnaces and ovens were in seventh place.

GROWTH RATE: Plan to acquire - present use

Rank: Present - 1985



Rankings by growth rate (plans to acquire divided by present use for each category) are shown in the second bar chart, which also shows last year's rankings on this basis. The growing importance of infrared techniques is evident in the changes in the uppermost rankings.

Another indicator of changes from year to year is the portion of respondents not giving any answers for present use or plans to acquire. In the present Trends survey, 2.7% did not indicate present use of any instrument, compared to 2.1% last year. For plans to acquire, "no" answers rose to 44% this year from 39.4% in last year's study.

As in earlier studies, the geographic distribution of respondents parallels the circulation of *R&D* magazine. This validates the results because that circulation is kept in proportion to the distribution of funds and personnel in the field. New England accounts for 6.7% of the respondents to the Trends survey, the Middle Atlantic region 18.3, East North Central 23.1, West North Central 8.1, South Atlantic 14.6, East South Central 3.9, West South Central 8.2, Mountain 4.8, and Pacific 12.3%.

By discipline, which was referred to earlier, 25.6% list engineering, 49.4 physical science, 20.9 life science or medicine, while 4.1 gave no answer. For last year's Trends survey, the comparable data were 20.7% engineering, 56.9 physical science, 19.6 life science or medicine, and 2.9 no answer.

By employer, 58.2% work in industry, 16.6 in universities, 14.2 in government, 2.9 in nonprofit organizations, 2.7 in medical research centers, 3.1 other, and 2.3 no answer. Corresponding data for last year were 59.2% industry, 14.1 universities, 16.0 government, 3.1 nonprofit, 2.4 medical research, 4.0 other, and 1.2 no answer.

By job function, 3.3% are corporate officers, 8.4 R&D executives, 15.2 project managers, 65.3 professional staff, 5.5 other, and 2.3 no answer. This is virtually the same as last year, when the corresponding figures were 4.0 corporate officers, 8.2 R&D executives, 13.6 project managers, 67.2 professional staff, 5.0 other, and 1.8 no answer.

This Trends survey was conducted by including a prepaid business reply card in a mailing to *R&D* readers in the United States in late September 1985. To meet deadlines, only replies received by early November could be included in the data here. **R&D**

GROWTH RATE (bar chart at left) is calculated with present use as base for each instrument category. Total includes all those who plan to acquire; new users are those who do not presently use that instrument but who plan to acquire. Difference is present users planning to acquire additional or replacement units in that particular instrument category.

PRESENT AND PLANNED USE: Data from 1,539 respondents — 1986	Use now								Plan to acquire within 1 yr								Growth rate plan to acquire — by present use							
	1980		Engineering		Physical science/701		Life sciences or medicine		Chemical		Physics		Earth science/702		Environmental		Other		No. of users		No. of users		No. of users	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	%	No.	%	%	No.	%
Analytical balances	1,311	85.2	284	72.1	688	90.4	292	71.0	141	9.2	31	7.9	81	10.6	25	7.8	10.8	121	9.2	20	1.5			
Analyzers, particle size	253	16.4	80	20.3	137	18.0	27	6.4	75	4.9	21	5.3	44	5.8	9	2.8	29.6	16	6.3	59	23.3			
Analyzers, polarographic	67	4.4	7	1.8	48	6.3	9	2.8	17	1.1	7	1.8	9	1.2	1	0.3	25.4	—	—	17	25.4			
Analyzers, thermal (DTA, TGA)	252	16.4	74	18.8	157	20.6	12	3.7	83	5.4	13	3.3	63	8.3	7	2.2	32.9	24	9.5	59	23.4			
Baths, constant temperature	904	58.7	172	43.7	454	59.7	244	76.0	101	6.6	21	5.3	56	7.4	23	7.2	11.2	65	7.2	36	4.0			
Centrifuges	401	26.0	101	25.6	404	53.1	265	82.6	87	4.0	8	2.3	27	3.5	19	6.1	7.6	35	6.2	19	2.4			
Chromatographs, gas	696	45.2	100	27.7	401	52.7	121	37.7	102	6.6	16	4.0	83	10.8	16	5.0	15.2	56	9.9	37	5.6			
Chromatographs, gas with IR	73	4.7	22	5.6	41	5.4	6	2.5	30	2.5	9	2.3	24	3.2	5	1.8	53.4	5	4.1	36	46.3			
Chromatographs, gas with MS	164	10.7	28	6.6	112	14.7	22	6.9	71	4.6	7	1.8	45	5.9	16	5.0	43.3	19	11.6	82	31.7			
Chromatographs, liquid	539	35.0	58	14.7	299	39.3	163	50.8	109	7.1	9	2.3	77	10.1	21	6.5	20.2	57	10.6	52	9.6			
Chromatographs, thin layer	300	19.5	20	5.1	154	20.2	115	35.8	26	1.7	4	1.0	12	1.6	6	1.9	8.7	12	4.0	14	4.7			
Electrophoresis apparatus	192	12.5	12	3.0	56	7.4	118	36.8	38	2.5	2	0.5	15	2.0	21	6.5	19.8	19	9.9	19	9.9			
Fume hoods	1,196	77.7	264	67.0	633	83.2	255	79.4	131	8.5	48	12.2	62	8.1	19	5.9	11.0	84	7.0	47	3.9			
Laboratory data mgmt. systems	506	33.1	117	29.7	290	38.3	106	32.7	247	16.3	32	8.2	38	5.0	48	15.3	46.8	79	11.9	177	31.8			
Laboratory furnaces, ovens	1,118	72.6	283	71.8	596	78.3	196	61.7	117	7.6	47	11.9	53	7.0	16	5.0	10.5	87	7.8	30	2.7			
Microscopes, electron	273	17.7	101	25.8	114	15.0	60	15.6	47	3.1	18	4.6	18	2.1	12	3.7	17.2	12	4.4	36	12.4			
Microscopes, optical	1,021	66.3	280	71.1	468	61.2	241	75.1	97	6.3	33	8.4	37	4.9	24	7.5	9.5	69	5.9	37	3.1			
Nuclear magnetic resonance eqpt.	156	10.1	23	5.8	112	14.7	16	5.0	38	2.3	4	1.0	25	3.3	6	1.9	23.1	14	9.0	22	14.1			
pH meters	1,094	71.1	210	53.3	553	72.7	288	89.7	106	6.9	22	5.6	53	7.0	27	8.4	9.7	89	8.1	17	1.6			
Recorders, strip chart	1,045	67.9	280	71.1	531	69.8	197	61.4	105	6.8	47	11.9	41	5.4	12	3.7	10.0	70	6.7	35	3.3			
Recorders, x-y plotting	596	38.7	195	49.5	295	38.8	85	26.5	105	6.8	49	12.4	41	5.4	13	4.0	17.6	44	7.4	61	10.2			
Specific ion electrodes	480	29.9	71	18.0	268	35.2	134	42.4	56	3.6	13	3.3	46	6.1	30	9.3	20.7	34	11.7	41	4.8			
Spectrometers, electron	52	3.4	16	4.6	25	3.3	7	2.2	9	0.6	3	0.8	6	0.7	1	0.3	17.3	3	6.8	6	11.5			
Spectrometers, mass	161	11.6	49	12.4	111	14.6	17	5.3	36	2.3	10	2.5	18	2.4	7	2.2	19.0	17	9.4	19	10.5			
Spectrometers, plasma, dc	34	2.2	6	1.5	25	3.3	2	0.6	8	0.5	3	0.8	5	0.7	—	—	23.5	—	—	8	23.5			
Spectrometers, plasma, ICP	62	4.0	9	2.3	48	6.3	2	0.6	30	1.9	7	1.8	22	2.9	1	0.3	48.4	4	6.5	26	41.9			
Spectrometers, x-ray	188	12.2	51	12.9	124	16.3	6	1.9	26	1.7	7	1.8	17	2.2	1	0.3	13.8	8	4.3	18	9.6			
Spectrophotometers, atomic abs.	383	24.9	55	14.0	265	34.8	49	15.3	29	1.9	3	0.8	21	2.8	5	1.6	7.6	10	2.6	10	5.0			
Spectrophotometers, fluorescence	197	12.8	26	6.6	90	11.8	74	23.1	22	1.4	1	0.3	7	0.9	13	4.0	11.2	4	2.0	18	9.1			
Spectrophotometers, FTIR	149	9.7	25	6.3	115	15.1	7	2.2	46	3.0	13	3.3	31	4.1	12	3.7	56.0	46	18.1	27	36.9			
Spectrophotometers, infrared	436	28.3	61	15.5	316	41.5	45	14.0	44	2.9	11	2.8	27	3.6	6	1.9	16.1	18	4.3	25	6.6			
Spectrophotometers, UV/vis	645	41.9	59	15.0	372	48.9	181	59.5	67	4.4	8	2.0	37	4.9	22	6.9	16.4	28	3.9	29	4.5			
Titrators, automatic	291	18.9	47	11.9	192	25.2	42	13.1	71	4.6	3	2.0	40	5.3	18	5.6	24.4	16	4.3	52	17.5			
Other	148	9.7	30	7.6	76	10.2	34	10.6	52	3.3	16	4.1	20	2.6	14	4.4	34.9	28	16.8	34	18.1			